writer with the 10-inch Cooke telescope, the variable star W *Cephei* was found to have Hα bright on objective-prism plates secured on November 2 and 3, 1921.

The line is strong, narrow, and well defined. No change in the intensity of the line can be detected on the two dates mentioned. The star has been classed as a possible *Cepheid*.[1] Harvard College Observatory gives the spectral type as K with a range of magnitude from 7.3 to 8.3. Observations of the light-curve by several observers would seem to show that it is irregular.

A slit spectrogram, taken by Mr. Merrill with the 100-inch telescope on November 14, 1921, shows Hα and Hβ bright.

M. L. HUMASON.

NOTE ON INVISIBLE SUN-SPOTS†

All available evidence, including the invariable presence of a magnetic field, the radial motions of the superposed gases observed at various levels, the inflow of neighboring prominences, and the structure of the hydrogen (Hα) flocculi, indicate that sun-spots are vortex phenomena, somewhat analogous to terrestrial tornadoes. The visibility of a spot, on this hypothesis, depends upon the degree of cooling produced by the expansion of the gases in the vortex. If this is sufficiently great, a dark cloud appears, which we recognize by direct visual observation. However, there may be stages in the life of a spot, during the period of formation or disintegration, when the cooling thus produced is insufficient to cause a visible change in the brightness of the photosphere. If the vortex, which is here regarded as the essential element of the spot, is actually present at such times, it might be detected through the Zeeman effect of its local magnetic field.

The phenomena of recurrent spots, and those of bipolar groups in which the minor member appears and disappears within short intervals of time, suggest the same possibility, and

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[1]Shapley, *Mt. Wilson Contr.*, No. 153.

†I have hesitated to use the term "invisible sun-spot," but it seems to be the simplest means of designating the invisible stage of spots which are usually visible during the greater part of their existence. A spot invisible to the eye, but rendered apparent on a photograph (if feasible) through the increased contrast resulting from the use of ultra-violet light, would undoubtedly be called a sun-spot. In the present case, which differs only in degree, a new term seems no more essential.

indicate the importance of making a systematic search for local magnetic fields which may betray the presence of incipient or dying spots.

The apparatus adopted for this purpose consists of a short strip of half-wave mica, mounted above the compound quarter-wave plate and Nicol ordinarily used in polarity observations of sun-spots. This is supported in a rectangular brass frame sliding in guides, and moved back and forth across the slit by a small electric motor. The observations are made with the Zeeman triplet λ6173.553 in the second order spectrum of the 75-foot spectrograph of the 150-foot tower telescope. A region of the Sun which the presence of faculæ, flocculi, or other evidence of disturbance indicates as promising, is made to move across the slit by the slow motion motor of the cœlostat, while the observer watches the λ6173 line. If a local field of sufficient intensity is encountered, λ6173 will be seen to shift at that point alternately to red and violet as the half-wave plate covers and uncovers the slit. Other forms of polarizing apparatus may of course be used, such as a rotating half-wave plate combined with quarter-wave and Nicol, a compound quarter-wave plate moved back and forth along the slit, etc. The one requirement is that the red and violet n components of the triplet shall be transmitted in succession, at such frequency as to produce the maximum effect on the eye.

The tables of magnetic classification of sun-spots which appear in this number contain some interesting cases of local fields thus detected. Spot No. 1920 appeared as a small bipolar group on November 22. Its following member, however, had been found by Ellerman and myself three days in advance, and was also magnetically observed by Ellerman in its invisible stage on November 20, and as a "faint marking" on November 21. Not far away (see notes) another local field, which did not result in a visible spot, was observed on November 19 and 20. The small following members of No. 1919, which disappeared on November 25, were still detected magnetically by Nicholson on November 26 and (as a "faint marking") on November 27. The unipolar spot No. 1924 was found by Ellerman on December 12 to be followed by a local field; two such fields were observed by him on the following day and became visible spots

on December 14. A few other cases of local magnetic fields, casually encountered before this systematic search was undertaken, occur in our records.

The field-strengths observed, from 200 to 500 gausses, are of the same order as those of the smallest visible spots.

GEORGE E. HALE.

SUMMARY OF MOUNT WILSON MAGNETIC OBSERVATIONS OF SUN-SPOTS FOR NOVEMBER AND DECEMBER, 1921

In the opening number of a new volume of these PUBLICATIONS it seems desirable to recapitulate the methods of observation and the scheme of classification underlying these tables. Reference must also be made to the inclusion hereafter of local magnetic fields, or invisible spots, which are described in a separate note.

Systematic observations of the magnetic polarities of sun-spots have been made daily with the 150-foot tower telescope since 1915. Summaries of the results have appeared regularly in these PUBLICATIONS since May, 1920, and preparations are being made for detailed publication, in graphical form, of the entire set of daily records.

The image of the Sun, 42.4 cm. in diameter, is projected upon a sheet of paper and a sketch of the spots is made. The approximate heliographic latitude and longitude of each group is read from a disk upon which the meridians and the parallels of latitude have been drawn. The magnetic polarity and approximate field-strength of each spot are then determined by the character of the polarization and the measured separation of the components of the Zeeman triplet λ6173.553 (Fe), observed in the second order spectrum of the 75-foot spectrograph.

The large solar image permits the polarities of very small spots to be determined, but since the lines of force at the center of a spot are generally normal to the Sun's surface, polarity observations are difficult for large spots and impossible for small ones when near the limb.[1] Local magnetic fields, or invisible spots, are also observed regularly whenever possible. In this

[1]For further details see *Mt. Wilson Contr.*, No. 165, *Ap. Jour.*, April, 1919.